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Meta-analysis of ultrasound-guided subserratus anterior plane block for analgesia and rapid recovery after upper abdominal surgery

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Abstract: *In this paper, a meta-analysis was performed to compare the analgesic effect and rapid recovery effect of ultrasound-guided subserratus anterior plane block in upper abdominal surgery. PubMed, Cochrane Library, EMbase, CBM, CNKI, Wanfang and VIP databases were searched by computer from the establishment of the database to May 2024, and a randomized controlled trial on the application of ultrasound-guided subserratus anterior plane block in upper abdominal surgery was included. The following information was extracted from the included literatures: sample size, BMI, sex ratio, age, ASA grade, operation duration, concentration, type and dose of local anesthesia drugs. Meta-analysis was performed using RevMan5.3 software. Results A total of 361 patients were included in 5 studies. The results of meta-analysis showed that compared with the control group, the experimental group can reduce at the resting state pain scores at 6 hours after surgery (MD=-0.63, 95% CI -0.75~ -0.50, P<0.00001) , the resting state pain scores at 12 hours after surgery (MD=-0.61, 95% CI -0.72~ -0.50, P<0.00001), the resting state pain scores at 24 hours after surgery (MD=-0.22, 95% CI -0.30~ -0.14, P<0.00001) , the resting state pain scores at 48 hours after surgery (MD=-0.12, 95% CI -0.20~ -0.04, P=0.005), the amount of sufentanil used during operation (MD=-17.04, 95% CI -18.24~ -15.84, P<0.00001) , the number of postoperative analgesia pump compressions (MD=-12.21, 95% CI -12.54~ -11.88, P<0.00001), the number of postoperative remedial analgesia cases (RR=0.08, 95% CI 0.03~ 0.18, P<0.00001), , the first time to exhaust gas (MD=-16.65, 95% CI -18.95~ -14.35, P<0.00001) , the incidence of nausea and vomiting (RR=0.12, 95% CI 0.06~0.25, P<0.00001) ,and the incidence of dizziness (RR=0.06, 95% CI 0.01~ 0.25, P=0.0001) . There was no significant difference in the first time to get out of bed (MD=-8.99, 95% CI -19.27~ -1.28, P=0.09) , the length of hospitalization (MD=-0.50, 95% CI -1.44~ -0.44, P=0.30) between the two groups. Ultrasound-guided subserratus anterior plane block can effectively improve the analgesic effect and accelerate the rapid recovery of patients through anesthesia in upper abdominal surgery.*

Keywords: *Ultrasound; subserratus anterior plane block; upper abdominal surgery; analgesia; Meta-analysis*

1. Introduction

With the current prevalence of abdominal diseases increasing year by year, the number of patients undergoing abdominal surgery has also increased; abdominal surgery is gradually presenting a trend of minimally invasive, and has the characteristics of postoperative recovery block, small traumatic and so on, but it is difficult to avoid the presence of intraoperative injuries in the course of the operation, coupled with the anesthesia method, anesthesia medication, the stimulation of the operating instrument and other factors are very easy to cause pain, increasing the difficulty of intraoperative anesthesia [1].Effective analgesia after upper abdominal surgery mostly requires epidural anesthesia combined with intravenous analgesia, and epidural analgesia has its own disadvantages and contraindications [2]. Ultrasound-guided nerve block has the advantages of small trauma, high accuracy, and few side effects, in which the anterior serratus plane block is to inject anesthetics in the deep or superficial surface of the serratus anterior muscle at the level of the 5th rib in the midaxillary line, which is widely used in breast surgery and thoracic surgery analgesia, and the subserratus anterior plane block is to move the point of anesthesia injection to the 8th rib in the midaxillary line, which is effectively used for post-operative analgesia after abdominal surgery [3].In view of this, the aim of this study is to analyze the analgesic effect and adverse

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reaction of ultrasound-guided subserratus anterior plane block in patients undergoing upper abdominal surgery, and to provide relevant basis for its application in clinic.

2. Data and methods

2.1 Inclusion and exclusion criteria

2.1.1 Research types

Randomized controlled trials published in Chinese and English.

2.1.2 Research object

(1) Inclusion criteria: Adult patients with upper abdominal surgery under subserratus anterior plane block combined with general anesthesia or general anesthesia alone, ASAI~II, centerless, lung, brain, liver, kidney and other system diseases. (2) Exclusion criteria: patients with contraindications of nerve block, diseases of the nervous system, diseases of the immune system, skin injury and infection at the anesthetic puncture site.

2.1.3 Interventions

The experimental group received ultrasound-guided subserratus anterior plane block combined with general anesthesia, and the control group received general anesthesia alone.

2.1.4 Outcome indicators

(1) Main indicators:the resting pain scores at 6h, 12h, 24h and 48h after surgery. (2) Secondary indicators: the amount of sufentanil used during operation, the number of postoperative analgesia pump compressions and the number of postoperative remedial analgesia cases, the first time to get out of bed, the first time to exhaust gas and the length of hospitalization, the incidence of postoperative nausea and vomiting and dizziness.

2.2 Search strategy

PubMed, EMbase, Cochrane Library, Chinese Biomedical Literature Database, Chinese Journal Full-text Database, Chinese Science and Technology Journal Database and China Wanfang Database were searched by computer from the establishment of the database to May 2024. Chinese search keywords: ultrasound guidance, ultrasound, subserratus anterior plane block, upper abdominal surgery; English search keywords: ultrasound guidance, ultrasound, subserratus anterior plane block, upper abdominal surgery. The search strategy uses logical operators "AND", "OR" and "NO T" to combine the search terms. Expand the scope of search and improve the recall rate by using thesaurus, free word and wildcard search, and using the combination of thesaurus and free word search; At the same time according to the specific database to adjust the search method.

2.3 Literature screening and data extraction

(1) Preliminary screening: According to the retrieved citation information such as title and abstract, obviously unqualified literature should be screened, and the full text of positive or uncertain literature should be found and then screened; (2) Read the full text: For the literature that may be qualified, the full text should be read and analyzed one by one, and then confirm whether it is qualified; (3) Contact with the author: once excluded, the literature will not be included. Therefore, if the information provided in the paper is incomplete and cannot be confirmed, or if there are questions and disagreements, the literature should be included first, and the relevant information can be obtained by contacting the author before making a decision; (4) The contents of the extracted data include :(1) the general information of the research object: the title of the paper, the author of the paper, the publication time of the paper and the source of the paper; (5) Characteristics of the research objects: the basic information of the research objects in the literature is selected, the comparability between the research objects, and the specific application of intervention measures; (6) Main indicators of detection: sample size, BMI, sex ratio, age, ASA grade, operation duration, concentration, type and dose of local anesthesia drugs.

2.4 Quality evaluation

The quality evaluation of the strictly selected included literatures was conducted according to the

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criteria of Cochrane5.0.2 Systematic Review Manual. The main contents included: whether the random assignment principle of study subjects was met, whether the concealment of the grouping scheme was met, whether the blind principle of grouping was complied with, whether there were complete data, and what caused the data bias. In the quality evaluation, the cross-checking of the data of the included literature was carried out independently by two researchers. The researchers jointly discuss or coordinate with a third researcher to resolve the differences encountered.

2.5 Statistical analysis of data

Meta-analysis was performed using RevMan5.3 software. Mean difference (MD) was used as the continuous variable of therapeutic effect analysis, and relative risk (RR) was used as the method of statistical analysis of count data. 95%CI was used to represent each effect size, and P<0.05 was considered statistically significant. Q test was used to analyze the heterogeneity among all studies, homogeneity (P>0.10, I^2<50%), and fixed effect model was used for meta-analysis. When there was heterogeneity (P<0.10, I^2>50%), the causes of inter-study heterogeneity were analyzed. Funnel plot analysis was performed for publication bias.

3. Results

3.1 Literature search results

15 literatures were initially retrieved, and 5 literatures [4-8] were finally included after layer by layer screening, with a total of 361 patients. See Figure 1.

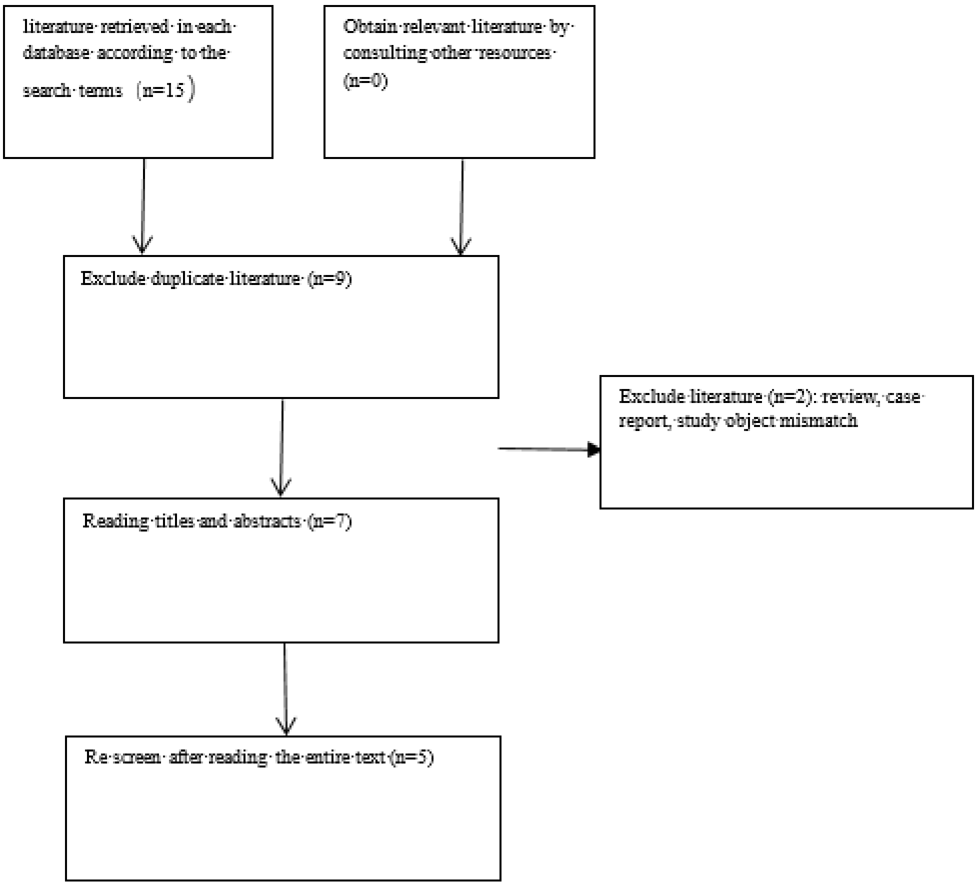

Figure 1: Literature Screening Process

3.2 Basic information and bias risk assessment of included literature

The basic characteristics of the included literature are shown in Table 1; The risk assessment of

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literature bias is shown in Figure 2.

Table 1: Basic characteristics of included studies

literature	sample size		Age (years)		Gender (male/female)		BMI(kg/cm²)		ASA classification (Level I/II)		Surgical time (min)		Local anesthetic dosage		Outcome indicators
	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group	
Zhu XB 2021 [4]	40	39	43. 7±17. 2	48. 2±12. 1	22/18	26/13	20. 3±2. 7	22. 2±1. 8	23/17	21/18	150. 7±11. 8	130. 2±23. 8	0.25% ropivacaine 30ml		5-7、11-12
Zhang MH 2022 [5]	40	40	61±9	62±11	28/12	29/11	23.8±3.6	22.7±2.4	35/5	33/7	185.9±43.4	197.3±51.6	0.25% ropivacaine 30ml		3-4、6-7、9-11
Cao F 2023 [6]	41	41	42.58 ± 5.62	42.03 ±5.78	26/15	25/16							0.4% ropivacaine 30ml		5-7、11-12
Qian JJ 2023 [7]	30	30	41.32±3.89	41.27±3.85	17/13	16/14	22.13±2.01	22.09±1.97	10/20	9/21			0.375% ropivacaine 40ml		1-5、8、11-12
Cheng ZP 2024 [8]	30	30	55±4	53±5							204±21	202.2 ± 19.8	0.375% ropivacaine 25ml		1-4、6-10

1, 2, 3 and 4 were resting pain scores at 6h, 12h, 24h and 48h after surgery, respectively;5, 6 and 7 were the amount of sufentanil used during operation, the number of postoperative analgesia pump compressions and the number of postoperative remedial analgesia cases, respectively. 8, 9 and 10 were the first time to get out of bed, the first time to exhaust gas and the length of hospitalization, respectively. 11 and 12 were the incidence of postoperative nausea and vomiting and dizziness, respectively.

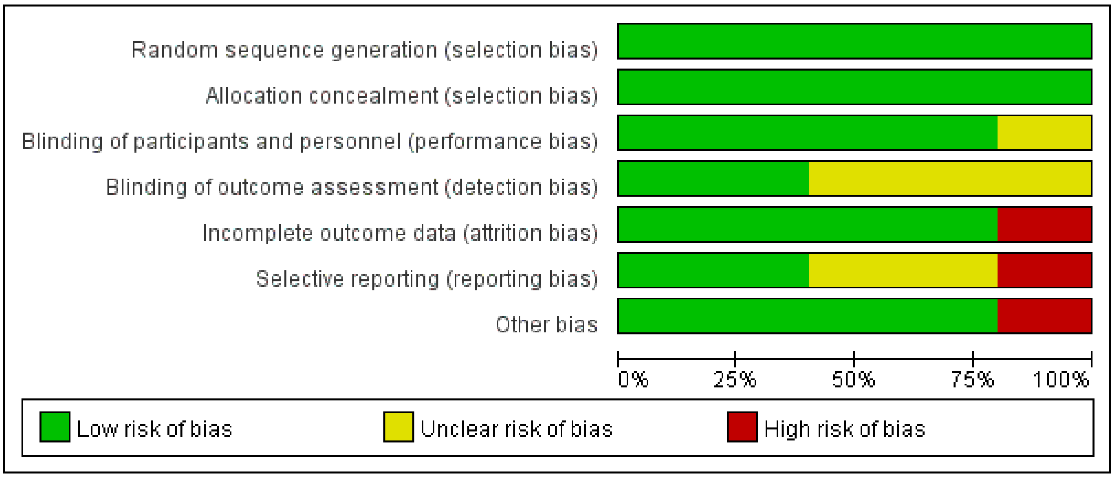


Figure 2: Bias Risk Assessment Chart

3.3 Results of meta-analysis

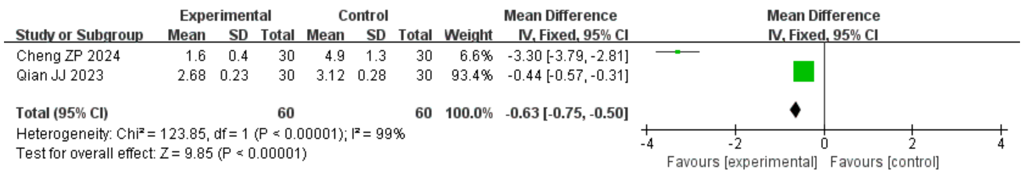
3.3.1 Resting state pain scores of patients in the two groups at different time points after surgery

Two articles [7-8] compared the resting state pain scores at 6 hours after surgery, showing significant heterogeneity (I^2=99%, *P*<0.00001). Using a random effects model, meta-analysis results showed that the resting state pain scores at 6 hours after surgery in the experimental group were significantly lower than those in the control group (MD=-0.63, 95% CI -0.75~ -0.50, *P*<0.00001) (Figure 3-A).

Two articles [7-8] compared the resting state pain scores at 12 hours after surgery, showing significant heterogeneity (I^2=99%, *P*<0.00001). Using a random effects model, meta-analysis results showed that the resting state pain scores at 12 hours after surgery in the experimental group were significantly lower than those in the control group (MD=-0.61, 95% CI -0.72~ -0.50, *P*<0.00001) (Figure 3-B).

Three articles [5, 7-8] compared the resting state pain scores at 24 hours after surgery, showing significant heterogeneity (I^2=93%, *P*<0.00001). Using a random effects model, meta-analysis results showed that the resting state pain scores in the experimental group were significantly lower than those in the control group at 24 hours after surgery (MD=-0.22, 95% CI -0.30~ -0.14, *P*<0.00001) (Figure 3-C).

Three articles [5,7-8] compared the resting state pain scores at 48 hours after surgery, showing without significant heterogeneity (I^2=0%, *P*-0.98). Using a fixed effects model, meta-analysis results showed that the resting state pain scores at 48 hours after surgery in the experimental group were significantly lower than those in the control group (MD=-0.12, 95% CI -0.20~ -0.04, *P*=0.005) (Figure 3-D).



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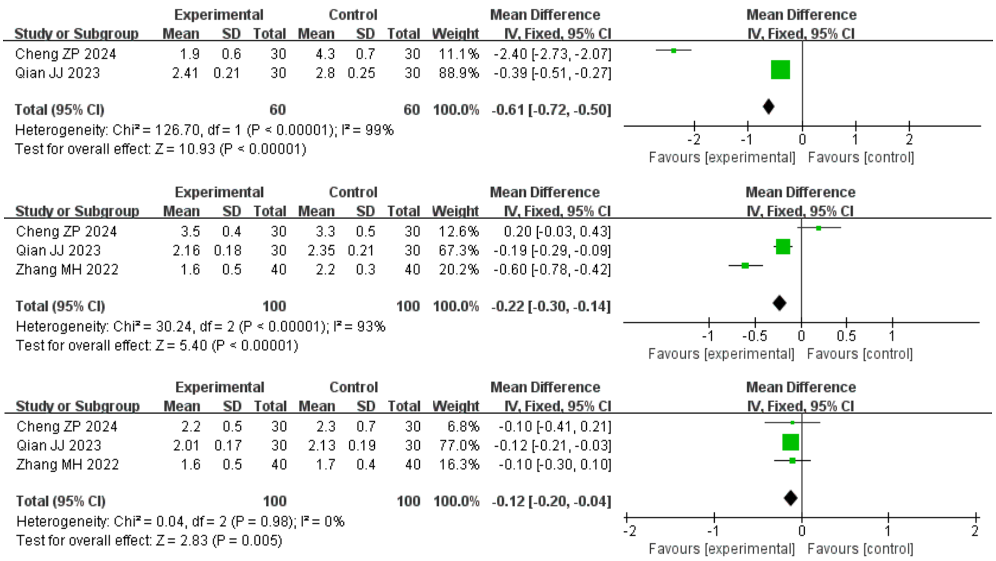


B

C

D

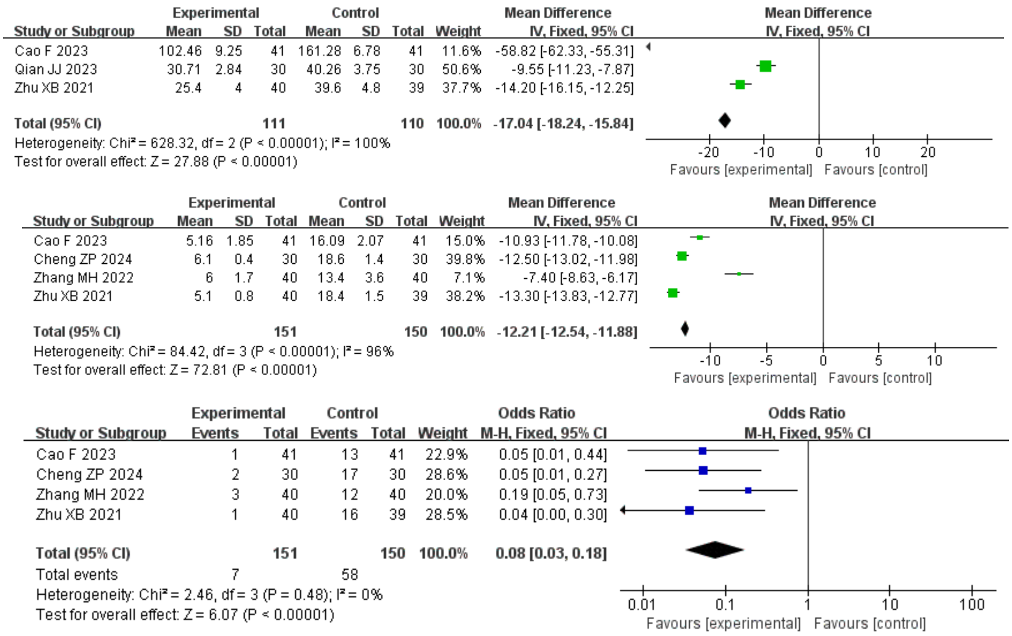
Figure 3: Resting state pain scores at different time points after surgery

3.3.2 Analgesia related secondary indicators

Three articles [4,6-7] compared the amount of sufentanil used during operation, showing significant heterogeneity (I^2=100%, *P*<0.00001). Using a random effects model, meta-analysis results showed that the amount of sufentanil used during operation in the experimental group were significantly lower than those in the control group (MD=-17.04, 95% CI -18.24~ -15.84, *P*<0.00001) (Figure 4-A).

Four articles [4-6,8] compared the number of postoperative analgesia pump compressions, showing significant heterogeneity (I^2=96%, *P*<0.00001). Using a random effects model, meta-analysis results showed that the number of postoperative analgesia pump compressions in the experimental group were significantly lower than those in the control group (MD=-12.21, 95% CI -12.54~ -11.88, *P*<0.00001) (Figure 4-B).

Four articles [4-6,8] compared the number of postoperative remedial analgesia cases, showing without significant heterogeneity (I^2=0%, *P*=0.48). Using a fixed effects model, meta-analysis results showed that the number of postoperative remedial analgesia cases in the experimental group were significantly lower than those in the control group (RR=0.08, 95% CI 0.03~ 0.18, *P*<0.00001) (Figure 4-C).



A

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Figure 4: Analgesia related secondary indicators

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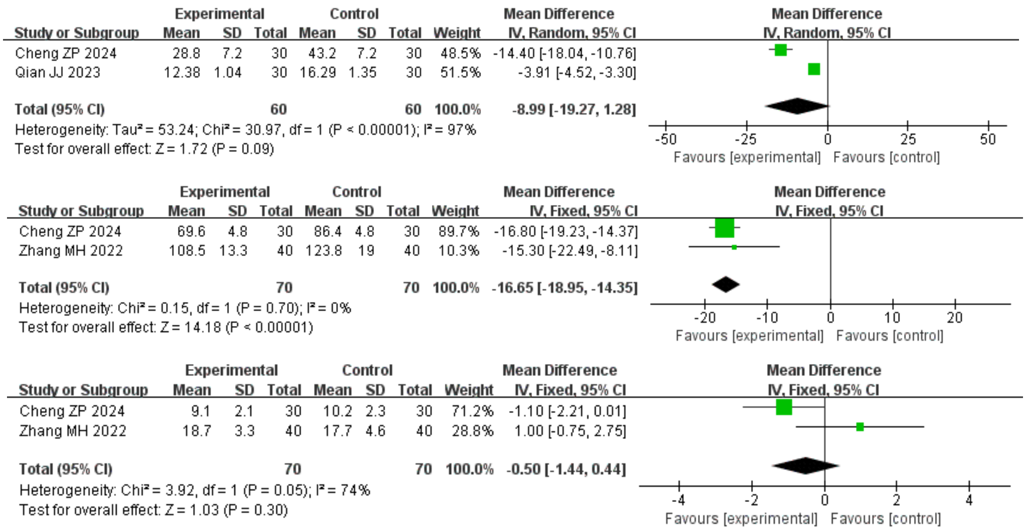
3.3.3 Postoperative rapid recovery related indicators

Two articles [7-8] compared the first time to get out of bed, showing significant heterogeneity (I^2=97%, *P*<0.00001). Using a random effects model, meta-analysis results showed that there is no significant difference in the first time to get out of bed between the two groups of patients (MD=-8.99, 95% CI -19.27~ -1.28, *P*=0.09) (Figure 5-A).

Two articles [5,8] compared the first time to exhaust gas, showing without significant heterogeneity (I^2=0%, *P*=0.70). Using a fixed effects model, meta-analysis results showed that the first time to exhaust gas in the experimental group were significantly lower than those in the control group (MD=-16.65, 95% CI -18.95~ -14.35, *P*<0.00001) (Figure 5-B).

Two articles [5,8] compared the length of hospitalization, showing without significant heterogeneity (I^2=74%, *P*=0.05). Using a fixed effects model, meta-analysis results showed that there is no significant difference in the length of hospitalization between the two groups of patients (MD=-0.50, 95% CI -1.44~ -0.44, *P*=0.30) (Figure 5-C).



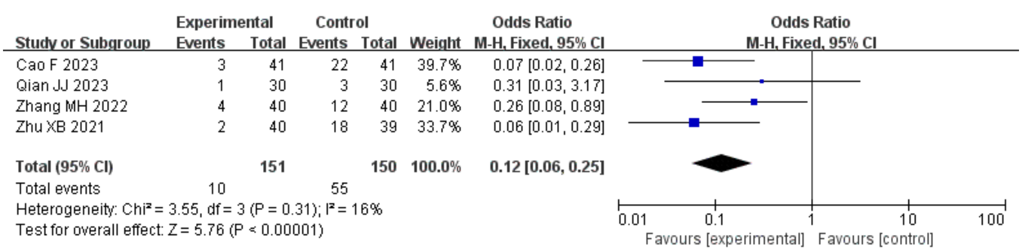
A
B
C

Figure 5: Postoperative rapid recovery related indicators

3.3.4 Postoperative adverse reaction

Four articles [4-7] compared the incidence of nausea and vomiting without significant heterogeneity (I^2=16%, *P*=0.31). Using a fixed effects model, meta-analysis results showed that the incidence of nausea and vomiting in the experimental group was significantly lower than that in the control group (RR=0.12, 95% CI 0.06~0.25, *P*<0.00001) (Figure 6-A).

Three articles [4,6-7] compared the incidence of dizziness without significant heterogeneity (I^2=0%, *P*=0.51). Using a fixed effects model, meta-analysis results showed that the incidence of dizziness in the experimental group was significantly lower than that in the control group (RR=0.06, 95% CI 0.01~ 0.25, *P*=0.0001) (Figure 6-B).



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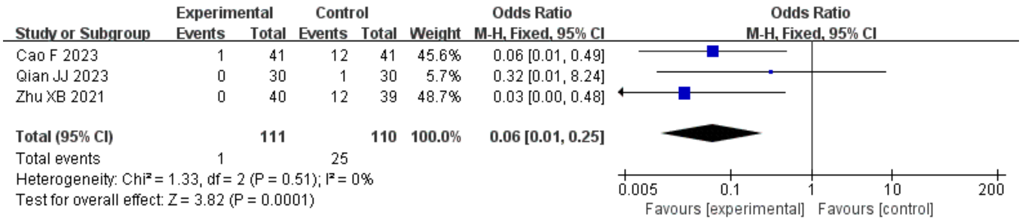

B

Figure 6: Postoperative adverse reaction

3.3.5 Publication bias

A funnel plot was drawn based on the incidence of nausea and vomiting. The funnel plot was symmetrically distributed, and the results indicated a relatively small publication bias. (Figure 7)

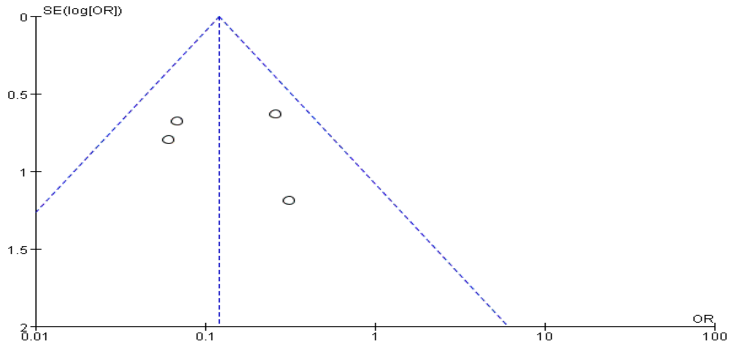

Figure 7: Funnel plot of publication bias in the incidence of nausea and vomiting

4. Discussion

Abdominal surgery has high requirements for anesthesia drugs and anesthesia methods. If the anesthesia methods and drugs are not properly selected, not only can the effect of anesthesia not be achieved, but also it is very easy to cause traumatic pain symptoms, which affects the degree of postoperative recovery of the patients, and is not conducive to the recovery of the patients. And traumatic pain in upper abdominal surgery will produce a stress response to the patient's body, inhibit the lymphatic system, and then reduce the immunity of the patient to pathogens, resulting in an increase in the incidence of postoperative complications, affecting the effectiveness of surgical treatment [9-10].Therefore, it is important to actively seek reasonable and effective anesthesia to reduce the rate of remedial analgesia and the degree of central nervous system injury in patients undergoing upper abdominal surgery.

With the concept of rapid recovery and the development of ultrasound visualization technology, the role of multimodal perioperative analgesia in perioperative recovery has received more and more attention. Compared with traditional anesthesia analgesia, ultrasound-guided regional block has the advantages of more intuitive and precise positioning and obvious analgesic effect[3] .The intercostal nerve crosses the serratus anterior muscle near the midaxillary line, and injection of local anesthetic into the superficial space of the serratus anterior muscle can effectively block the lateral cutaneous branch of the intercostal nerve. Local anesthetics have limited diffusion ability in the fascial plane near the serratus anterior muscle, so the blocking range of the serratus anterior muscle is different in different locations.Elsharkawy et al.[11] performed the T7-T8 subserratus anterior plane block in a fresh cadaver, and the diffusion range of the subgallant blue was T4-T10.In this study, the injection sites of T8-T9 were used, and after blocking 30% of the lateral cutaneous branch of the intercostal nerve, the diffusion range of the subgallant blue was T4 to T10. In this study, the injection sites of T8 to T9 were used, and the patients' sensory loss planes were T5 to T11 30 min after the block, which could provide analgesia for upper abdominal surgical incisions[12] .Therefore, ultrasound-guided subserratus anterior plane block can theoretically provide good and long-lasting analgesia in patients undergoing upper abdominal surgery, and for this reason we included relevant literature in a meta-analysis to confirm its analgesic effect and to investigate the occurrence of adverse events.

The results of this Meta-analysis suggest that compared to general anesthesia alone, ultrasound-guided subserratus anterior plane block combined with general anesthesia in patients undergoing upper abdominal surgery showed a significant decrease in resting state pain scores at 6 hours postoperatively,

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12 hours postoperatively, 24 hours postoperatively, and 48 hours postoperatively, and that the number of postoperative analgesic pump compressions, the amount of sufentanil used, and the number of The number of postoperative analgesic pump compression, the use of sufentanil and the number of postoperative remedial analgesia cases also decreased significantly, which may be due to the fact that the anesthesia medication can diffuse to T7 - T11 through ultrasound-guided subserratus anterior plane block, which can cover the surgical incision well and block the dermatomal nerve of the segment directly, and reduce the pain triggered by surgical stimulation effectively[12-13].Compared with the control group, the experimental group had a significantly shorter time to the first postoperative expiration of gas, and the incidence of adverse events such as postoperative nausea and vomiting and dizziness was significantly reduced, indicating that ultrasound-guided subserratus anterior plane block does not increase adverse events and can promote rapid recovery of patients.

In summary, the results of the analysis of this study suggest that, compared with the control group, the early postoperative resting pain in patients under ultrasound-guided subserratus anterior plane block compound general anesthesia for upper abdominal surgery was significantly relieved, and the amount of intraoperative sufentanil and the number of times of postoperative remedial analgesia were reduced, and the patients' first time of exhaustion was shortened, and the incidence of postoperative adverse reaction events also This suggests that ultrasound-guided subserratus anterior plane block can provide perfect postoperative analgesia, which in a certain sense realizes the concept of accelerated rehabilitation surgery, reduces the incidence of perioperative complications, and accelerates the postoperative recovery of patients.

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